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United States Department of Agriculture
Agricultural Research Service

Report of

ANNUAL CORN AND WHEAT UTILIZATION CONFERENCE

Northern Utilization Research and Development Division
and
Corn Industries Research Foundation
Technical Committee

Peoria, Illinois

June 18, 1963

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SUMMARY

The Conference was opened by Dr. F. R. Senti who introduced those in attendance and briefly outlined chemical, physical, and fermentation research of the Division on cereals and other research of interest contracted in this country and abroad.

Continuing studies on amylomaize starches have yielded improved separations of fractions and additional confirmation of the more linear structure of the amylopectin from this type compared to ordinary dent corn amylopectin.

Essentially complete solubility of high-amylose (70%) corn starch has been attained with an improved solvent system containing 5 M lithium thiocyanate plus 1-2 M guanidinium thiocyanate, with apparently little or no degradation. This is in contrast to about 88 percent solubility with the more conventional normal alkali or 90 percent dimethylsulfoxide. The possible mechanism of the enhanced action is discussed.

A component of mature dent corn starch, amounting to about 6 percent of the starch with the sedimentation behavior of amylose but the branching characteristics of amylopectin, was described. Neither waxy nor amylomaize starches appear to contain this fraction.

The densities of a series of amylomaize starches varying in amylose content from 50 to 70 percent were found to decrease from 1.488 to 1.482 with increasing amylose content. Ordinary dent corn starch had a density of 1.489 and waxy 1.485. Possible structure in relation to properties was discussed.

Hand-dissected fractions of yellow corn were analyzed for carotenoids and the proportion of total carotenoids in each fraction was calculated: horny endosperm - 80, floury - 16, germ - 3, and bran - 1 percent. Carotenoids in samples of commercial corn were found to vary three- to fourfold and carotenoids in the gluten feed and meal from processing such corn were found to vary similarly.

Comparative studies on the proteins of corn samples varying widely in amylose content (2.5-53% amylose) revealed only small differences in amounts of saline- and alcohol-extractable nitrogen, particularly between waxy and nonwaxy types, and no qualitative differences in starch-gel electrophoretic patterns.

A progress review on four phases of the use of cereal xanthates in paper products revealed the following accomplishments:

1. Continuous xanthation of starch to a practical degree of substitution (0.15 D.S.) has been accomplished in 2.75 minutes and an estimate was made of processing costs for a 50-ton-per-day unit of 2.5-3.0 cents per pound plus the cost of the cereal raw material.

2. Detailed analytical studies showed the products to be uniformly xanthated over a considerable range of D.S.

3. Incorporation of around 10 percent of zinc starch xanthate into insulation board gave improved dry strength and lower density, but contrary to results in paper, no increase in wet strength.

4. Liner board for corrugated boxes having 85 percent of the required increased stiffness at high humidities was produced by use of 5 percent starch xanthide of 0.12 D.S. It appears that board having the desired properties may be fully attained by use of appropriate xanthides and procedures.

The ARS Culture Collection is the only collection in the United States devoted to assembly and maintenance, taxonomy, and dissemination of microorganisms important to agriculture and industry. Its nearly 14,000 strains of permanent cultures and an equal number in the "temporary" collection are an indispensable base for surveys of molds, yeasts, and bacteria useful for the production of vitamins, microbial polymers, enzymes, and fermented foods now under study at the Northern Division.

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PROGRAM

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Morning Session

Introduction. . . . . F. R. Senti

Fractionation and Characterization of High-Amylose Starch . . E. M. Montgomery

A New Solvent System for Starch . . . . S. R. Erlander

A Low-Molecular Weight Component in Corn Starch . . . . J. P. McGuire

Density of Granular Amylomaize Starches as Determined in a Density Gradient Column. . . . . H. F. Zobel

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Afternoon Session

Corn Proteins, Including Possible Interrelationship Between Classes of Proteins . . . . J. H. Woychik

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The Role of the ARS Culture Collection in the Development of New Fermentation Processes . . . . C. W. Hesseltine

Open Discussion

INTRODUCTION

F. R. Senti

Dr. F. R. Senti opened the Conference by welcoming visitors, introducing those in attendance, and discussing arrangements. He briefly outlined research of the Division on cereals and other research of interest contracted in this country and abroad.

In the Cereal Properties Laboratory basic work on starch includes two studies which are reported at this meeting: (1) starch granule dispersion and amylopectin aggregation and (2) a new low molecular weight component of starch. Other investigations in progress are on electron microscopy of starch granules; interactions of starch and protein; conditioning wheat for milling, particularly as affecting separations by air classification; proteins of corn and minor constituents--free amino acids and nucleotides in corn extracts and steep liquors; N-derivatives, metal chelates, polymers, and addition compounds of dextrose; reactions of starch with amino acids, peptides, and acetylene; and effects of fluid flow dynamics on starch reactions.

In cooperation with the Crops Research Division, the genetic approach to utilization is the basis for our studies on high-amylose corn analyses (18,000 samples in 1962), properties of starches from different genetic stocks, wet-milling properties of high-amylose corn (ED), amylose analyses of single kernels with regard to location on the ear, and analyses of xanthophylls and carotenes.

In the Cereal Products Laboratory work is continuing on cereal xanthates for paper and board products and on uses of dialdehyde starch for more water-resistant casein and soybean protein glues.

Fermentation studies include:

1. Bacterial polysaccharides--separation, properties, and structure
2. Continuous fermentation processes
3. Beta-carotene production and screening of microorganisms for production of xanthophylls
4. Screening of fleshy fungi for new glucans
5. Screening for new plant disease antibiotics
6. Japanese beetle project to develop a fermentation method for production of milky disease spores

Contract research in 1963 was increased and the following investigations in the United States involve cereals research:

Stanford Research Institute--graft copolymers of cereal starches with vinyl-type monomers.

Arizona State--interaction of "V"-amylose with small molecules.

Battelle--production of starch xanthides and use in papermaking; allylated DAS in protective coatings.

Three contracts on sporulation of the milky disease organism of the Japanese beetle at Michigan State, Illinois, and Minnesota, and one on stable vegetative forms of the organism at Kansas State.

Under Public Law 480, 10 research projects in Israel, France, Italy, England, and Yugoslavia are yielding important contributions to our knowledge of:

Reactions of Starch with Fluorine

Structure and Properties of Starch and Derivatives

Alterations in Starch Induced by Radiation

Polymers of Glucose and Derivatives

Enzyme-Inhibiting Effects of Starch and Flour

Nature and Specificity of Enzymes

Rheological Properties of Zein

Modification of Cereal Starches by Physical Treatments

Kinetics of Hypohalite Oxidation of Starch

FRACTIONATION AND CHARACTERIZATION OF HIGH-AMYLOSE STARCH

Edna M. Montgomery

A neutral chemical steep was used to isolate amylomaize starches in high yield by laboratory wet-milling procedures. Advantages of the method are that no hydrolysis of glycosidic links takes place during steeping; separated starch is low in protein content; and good separation of small- and normal-size granules can be made.

Separation of linear and branched starches produced amylose of high purity and high-molecular weight. Amylose was converted to maltose by β-amylase to an extent of 96 percent; had iodine affinity of 200+ mg. I_2/g. and an intrinsic viscosity in 1 N potassium hydroxide of 1.63 to 1.68.

Structural investigations of amylopectins of amylomaize confirmed previous investigations. A difference in structure exists between this fraction and that of ordinary corn. The chains extending beyond the branch points show increased length in the former. Purity of amylopectins was shown by paper and thin-layer chromatography and by ultracentrifuge patterns.

A NEW SOLVENT SYSTEM FOR STARCH

Stig R. Erlander

A new solvent system was discovered by combining lithium salts with guanidinium salts. The resulting solvent system has greater solvent power for starch granules than the individual salts themselves. The dispersing action of the solvent or the solvent mixture was followed with time by using a light-scattering machine. Constant turbidity was obtained within 3 or 4 hours after adding the solvent to the wet starch granules. The total solubility of the starch granules was obtained after 24 hours in the solvent mixture by removing the insoluble starch by centrifuging at 18,000 r.p.m. for 15 minutes and determining the optical rotation.

High-amylose corn starch having an apparent amylose content of 70 percent was used as the substrate to test the solubility power of the different solvents. Both lithium thiocyanate and lithium bromide showed a maximum with varying concentrations in their dispersibility of the high-amylose corn starch. This maximum occurred at approximately 6 M lithium bromide or lithium thiocyanate at room temperature and pH 7. In contrast to this, the guanidinium hydrochloride and guanidinium thiocyanate continued to increase in solvent power even to the point of saturation. In a mixed solvent system, the guanidinium thiocyanate was again greater in dispersing power than the guanidinium hydrochloride, which was in turn greater in dispersing power than urea. In all cases studied, the mixture of lithium bromide plus guanidinium hydrochloride produced a solvent which had enhanced solubility power greater than the solubility power of the individual salts. For example, the solubility of the high-amylose corn starch at room temperature and neutral pH in 6 M lithium bromide is approximately 65 percent and in saturated guanidinium hydrochloride is about 55 percent. In 6 M lithium bromide plus 2.5 M guanidinium hydrochloride, the solubility of the high-amylose corn starch is increased to about 93 percent. This same increase was observed for lithium thiocyanate plus guanidinium thiocyanate salt mixtures. The best solvent system appeared to be 5 M lithium thiocyanate plus 1 or 2 M guanidinium thiocyanate. Essentially complete solubility was achieved in this solvent system for the high-amylose corn starch. This is much better than normal alkali or 90 percent dimethylsulfoxide where the total solubility of the high-amylose corn starch was approximately 88 percent in both cases after 24 hours.

In addition, the dimethylsulfoxide appears to enhance the hydroxyl ion action on the starch, and hence acts as an alkali solvent. Degradation has been shown to occur in both the dimethylsulfoxide and alkali solvent systems. High-molecular weights and high viscosity were obtained for dent corn starch amylose dispersed by using the lithium bromide plus guanidinium hydrochloride solvent systems. A molecular weight of 476,000 and a water viscosity of 0.89 were obtained for the dent corn amylose. In addition, a molecular weight of 381,000 and a viscosity of 0.79 was obtained for the amylose separated from the 70 percent high-amylose corn starch. A molecular weight of 1.7 million was obtained for potato amylose.

After correcting the specific rotations for refractive index, it was observed that the specific rotation of animal glycogen in guanidinium and lithium salt solutions decreased linearly as the salt concentration increased. In addition, the change in specific rotation as a function of molecular weight for different oligosaccharides going from maltose to glycogen was the same for the lithium bromide and the guanidinium hydrochloride solvent. This suggests that the lithium ion and the guanidinium ion attach themselves to the carbohydrate chain in a similar manner. It was also observed in this Laboratory that amylose or amylopectin in 4 M guanidinium chloride will precipitate if the pH is raised to 9 or 10. This also suggests that the guanidinium ion attaches itself to the hydroxyl groups on the chain. That is, it is known that alkali imparts a negative charge to carbohydrate chains. Therefore, at pH 9 or 10, one could explain the precipitation of the starch as due to electrostatic attraction between the positive and negative ions on the chain.

It is therefore concluded that in both the lithium salts and the guanidinium salts the dispersing action is due to the breakage of existing hydrogen bonds by attaching the positive ion to the hydroxyl groups on the chain and, in addition, is due to the electrostatic repulsion of the resulting positively charged chains. The increase in solvent power of the mixed solvent system is most likely due to an increase in the apparent concentration of the guanidinium ion caused by a decrease in the activity of the water.

Preliminary experiments suggest that amylose can be separated from amylopectin by the slow addition of acetone to the guanidine plus lithium salt solution containing the dispersed starch.

A LOW-MOLECULAR WEIGHT COMPONENT IN CORN STARCH

James P. McGuire

During an investigation of the composition of corn starch at various stages in its development, an incongruity between the amount of amylose in mature dent corn starch as shown by ultracentrifuge patterns and by spectrophotometric determinations was observed. The ultracentrifuge data showed 33 percent amylose, while the colorimetric method showed 27 percent.

An investigation of the differences has led to the isolation of a component with the sedimentation behavior of amylose but the branching characteristics of amylopectin.

To establish the fact that the high results were not an artifact of the dispersion method, a sample of waxy corn starch was run by the same method and the resulting centrifuge pattern revealed a single peak.

As part of the story, high-amylose corn was run at several concentrations for long periods of time at high speeds. However, after prolonged running, the high-amylose corn would not yield separate peaks in the ultracentrifuge.

To study the amylose peak of the dent corn a partition cell was used. The isolated material was treated with thymol to precipitate the amylose. The material left in the supernatant was then examined for physical properties. The sedimentation coefficient was 2 Svedbergs, the absorbancy was 83 compared to 61 for dent corn amylopectin and 364 for dent corn amylose. The percent branching by periodate oxidation was 4.8 percent. Molecular weight studies by the ultracentrifuge equilibrium method showed the polymer to be concentration dependent. The extrapolated weight-average molecular weight ($\bar{M}_w$) was 1.43×10^8. and the extrapolated Z-average molecular weight was 3.13×10^6. The ratio $\bar{M}_z/\bar{M}_w$ and the concentration dependence for the $\bar{M}_w$ and $\bar{M}_z$ extrapolations indicated further that the component is a branch polymer.

DENSITY OF GRANULAR AMYLOMAIZE STARCHES AS DETERMINED IN A DENSITY GRADIENT COLUMN

Henry F. Zobel

Amylomaize starches are more resistant to swelling than ordinary corn starch and autoclave temperatures are required to swell amylomaize starches to the point of rupture and dispersion into solution. This resistance to swelling and dispersion suggests that the granule might be more tightly organized and densely packed than ordinary starch. Density-gradient columns were used to determine an average granule density as a measure of molecular packing within the granule for 17 amylomaize starches varying from 33 to 70 percent in apparent amylose. Granule density of starches with about 10 percent moisture decreased from 1.488 to 1.482 as the apparent amylose content increased from 50 to 70 percent. Density of waxy maize starch with essentially no amylose was 1.485, an ordinary corn starch was 1.489, and potato starch was 1.492.

X-ray diffraction patterns indicated that the low density of the amylomaize starches could be attributed in part to the presence of the V or helical structure in these starches and in part to a lower overall crystallinity. In the range of 50-70 percent apparent amylose the crystallinity was of the B type or that of potato starch, while the 33-percent sample showed the A type crystallinity or that of ordinary corn starch.

If the low density is caused by the presence of the V structure, the density should increase if the V structure is destroyed by defatting the starch and slurrying in water. Accordingly, defatted amylomaize starches with the B structure increased in density by 0.005 unit, while potato starch increased by 0.002 unit, and a starch with the A structure (33% amylose) showed an increase of 0.006 density unit.

Discussion. The amylomaize starches in this series are primarily those with an *ae* genetype. Three starches, however, typed as su_2 or *ae* su_2, showed no significant differences in density with *ae* starches of the same amylose level.

DISTRIBUTION OF CAROTENOIDS IN THE CORN KERNEL

C. W. Blessin

Three lots of whole yellow corn were hand-dissected into bran, germ, floury endosperm, and horny endosperm. Two of the corns were known hybrids representative of those grown in the Central Corn Belt; the third was a mixture used for commercial milling. Components from each lot were analyzed for xanthophylls and carotenes. Xanthophylls comprised the greater portion of carotenoids in all fractions. Average total carotenoid contents of hand-dissected fractions in parts per million (p.p.m.) were: whole corn, 19; bran, 2; germ, 5; floury endosperm, 9; and horny endosperm, 28. Distribution of carotenoids in the kernel, based on relative weights of the four major fractions in percent were: bran, 1; germ, 3; floury endosperm, 16; and horny endosperm, 80.

Samples of commercial hybrid yellow dent corn showed a three- to fourfold variation in xanthophylls (10-30 p.p.m.) and carotenes (1-4 p.p.m.). Variation in the total carotenoid content (247-379 p.p.m.) of two commercial samples of corn gluten containing 60-70 percent protein was of the same magnitude as differences in the carotenoid level (19-30 p.p.m.) of the whole corn used for processing. The total carotenoid content of gluten feed (21% protein) varied from 14 to 34 p.p.m. and that of gluten meal (41% protein) from 65 to 253 p.p.m. Apparently the carotenoid content of gluten feed and gluten meal depends upon the type and amount of materials blended during processing.

CORN PROTEINS, INCLUDING POSSIBLE INTERRELATIONSHIP BETWEEN CLASSES OF PROTEINS

J. H. Woychik

Comparative studies on the proteins of corn varieties having starches of widely differing amylose content were undertaken to provide basic information related to the processing of such new types as high-amylose corn. The zein, glutelin, and globulin fractions of waxy, normal dent, and amylomaize hybrids were examined. These hybrids were isogenic except for the wx and ae genes in the waxy and amylomaize types. The amylose contents were 2.5, 26, and 53 percent for the waxy, dent, and amylomaize hybrids.

Comparisons were made of the percent extractable nitrogen. The waxy variety contained somewhat more saline-extractable nitrogen than the normal and amylomaize corns (21.2 vs. 17.5%) and less alcohol-extractable nitrogen (18.5 vs. 22.3%). The alkali-extractable nitrogen of the waxy corn was comparable to the other corns. The dent and amylomaize hybrids were essentially identical in nitrogen extractability.

Examination of the starch gel electrophoretic patterns of the zein, globulin, and glutelin fractions of these varieties revealed no qualitative differences in component distribution. Quantitative evaluations of the electrophoretic patterns were not done. The failure to detect any readily apparent differences in the protein content of the isogenic hybrids indicates the enzymes (presumably in the globulin fraction) responsible for the starch characteristics of the particular hybrid are not present in increased amounts or at the expense of other constituents. The responsible enzymes of course, could be very minor constituents, whose variation was not readily detected or entirely absent from the protein fraction studied.

Fractionation studies of the globulin fraction were also presented.

REVIEW OF PROGRESS ON USE OF CEREAL XANTHATES IN PAPER PRODUCTS

C. R. Russell

Preliminary studies, reported at the previous meeting, showed that minor to relatively large amounts of cereal products could be incorporated readily in paper by crosslinking cereal xanthates in the presence of wood pulp and converting the resulting furnish into paper by usual processes. These experimental papers had high, permanent wet strength, and improved dry strength properties except for tear which was reduced. The potentialities of the process for increasing industrial utilization of cereal grains were such that considerable added emphasis was given to this program during the past year. The new phases of research undertaken were: (1) development of a rapid continuous process for xanthation of starch, (2) determination of uniformity of substitution in starch xanthate produced by continuous processing, (3) development of high-strength insulating board from blends of crosslinked wheat flour xanthate and wood pulp, and (4) use of crosslinked xanthates to improve crush resistance of liner board for corrugated boxes at high humidity.

Continuous Xanthation

Studies on the continuous xanthation of starch in a model P-50, Baker Perkins, 2-inch Ko-Kneader showed that starch could be xanthated up to a degree of substitution (D.S.) of about 0.15 with high chemical efficiency in a mixing time of 2.75 minutes. At higher D.S.'s the Ko-Kneader products had to be aged for periods of up to 1 hour to achieve good chemical efficiency. Optimum mole ratio of reactants and operating conditions for achieving D.S.'s up to 0.4 were established from a statistical analysis of 144 runs in which reaction conditions were varied over a considerable range. Because xanthates having D.S.'s in the range of 0.10 to 0.15 appear best suited for use in paper, a preliminary cost estimate was made for producing starch xanthate of D.S. 0.12 in a 50-ton-per-day unit and converting it to xanthide (the oxidatively crosslinked product). The calculated cost to make including all charges for chemicals, equipment, buildings, labor, overhead, taxes, etc. but excluding profit and sales cost was approximately 3 cents per pound above the cost of the cereal raw material. Economies which appear possible to achieve could reduce this figure to about 2-1/2 cents.

Uniformity of Xanthation

In view of the short mixing time, 2.75 minutes, employed in the continuous xanthation process, the following studies were conducted to determine if the starches were uniformly xanthated, i.e., did not contain significant amounts of unreacted starch. Xanthates of D.S. 0.12 and 0.34 were each converted into the stable N,N-diethyl chloroacetamide derivative and fractionated by solvent-nonsolvent precipitation into several fractions. All fractions from each xanthate had, within experimental error, the same N and S content indicating that the starch was uniformly xanthated. The above starch xanthates were also converted by a series of chemical reactions into

methyl starches wherein methyl groups were attached to all positions previously occupied by xanthate groups. Separation of each methyl starch with Pentasol into methyl amylose and methyl amylopectin and subsequent determination of methoxyl showed that both fractions had the same D.S. The methyl starches are currently being hydrolyzed to obtain methyl glucose(s) for determining distribution of substitution within the glucose unit.

Upgrading Insulating Board

Studies of an exploratory nature on the use of crosslinked wheat flour xanthates to upgrade insulating board showed that best overall results with respect to retention, pulp drainage time, and board properties were achieved by incorporating 10 percent zinc starch xanthate into ground wood used for commercial production of insulating board. At this level of addition the experimental boards were only 83 percent as dense as commercial boards and hence should have better insulating properties. When densities of the boards were adjusted to a common value, the experimental boards had approximately twice the dry tensile strength and modulus of rupture as commercial boards. Contrary to results achieved in paper with zinc xanthates, their use in insulating board did not significantly increase wet strength of the board, nor was wet strength achieved by use of oxidatively crosslinked xanthates. High dry strength was obtained with the latter but results were not as good as those achieved with the zinc xanthates.

Increasing Stiffness of Liner Board at High Humidity

About 16 million tons of paper board are used annually in the United States to make corrugated boxes, paper cartons, and other rigid containers. In many shipping and storage applications where high humidities are encountered these cardboard boxes are not satisfactory because they lose their stiffness and sag. There is, therefore, considerable interest in developing additives which will prevent corrugated boxes from losing their stiffness at high humidity. The object of the industry is to produce a treated box which will retain at 90 percent relative humidity at least 90 percent of the stiffness of an untreated box at 50 percent relative humidity. If the stiffness of liner board, as determined by the ring crush test, can be made to meet the above specifications it is generally found that boxes of sufficient stiffness can be produced. This has been accomplished elsewhere by incorporating 15 percent phenolic resin in liner board but the board is too brittle to fabricate into boxes. In preliminary studies with starch xanthide (formed *in situ* from D.S. 0.12 xanthate) about 85 percent of the required increase in stiffness of liner board was achieved at a xanthide content of about 5 percent. With this particular xanthide higher levels of addition failed to give further increases in stiffness. However, it is felt that 100 percent of the desired increase in stiffness can be obtained through one or more of the following variations: Use of higher D.S. xanthides, better mixing or beating to assure more uniform distribution of xanthide on the wood pulp fibers, or use of additives such as rosin.

In addition to the above major research projects a continuous papermaking run was carried out at Forest Products Laboratory, Madison, Wisconsin, where

60 pounds of a 50/50 hardwood-softwood blend was treated with wheat starch xanthide to produce an unfilled bond paper containing 13 percent xanthide. Compared to the all wood pulp control paper the paper containing the xanthide was much stronger. Improvements in wet- and dry-tensile strengths, burst, and folding endurance were 500 percent, 60 percent, 120 percent, and 1,400 percent, respectively. Tear was lowered 40 percent and brightness 9 percent. One thousand sheets of this paper were sent to the Nebraska Wheat Commission and were used as inserts in the first issue of Wheat Abstracts. This run showed that xanthide-wood pulp furnishes could be readily converted to paper on conventional equipment. However, it was also evident that additional equipment such as pH control systems, better mixers, and ventilating systems would be required in the step where xanthate is mixed with pulp and oxidatively converted in situ to the xanthide. In view of this and other advantages, studies have been initiated on the development of an ex situ process, i.e., one in which xanthide is prepared in the absence of pulp and added later as currently practiced with other additives. In preliminary trials, ex situ xanthides have given about one-half the strength improvements achieved with in situ xanthides. Because of these encouraging results major emphasis is currently being placed on the development of more active ex situ xanthides.

THE ROLE OF THE ARS CULTURE COLLECTION IN THE DEVELOPMENT OF NEW FERMENTATION PROCESSES

C. W. Hesseltine

The ARS Culture Collection started in 1904 when Dr. Charles Thom, working for the Department of Agriculture, began a study of molds to be used in the manufacture of Roquefort and Camembert cheeses. Each of these cheeses was made by molds of the genus Penicillium. These cultures, which he isolated, are still in the Collection today and we have a few that were isolated before 1900. The Collection was formally established in 1940, at Peoria, and it now contains three parts devoted to yeasts, bacteria, and molds. The Collection is the only collection in the United States which is devoted to the assembly, study, and maintenance of microorganisms important to agriculture and industry. It consists of about 13,559 permanent strains of microorganisms and some 14,000 additional ones in the temporary Collection (not being permanently maintained). We supply about 2,000 to 2,500 cultures per year to people outside of the laboratory of which about three-fourths are requests from industry, and other government and university laboratories in the United States. Cultures are used for assay, as tools for both biochemical and genetic research, taxonomy or the classification of microorganisms, and lastly, for the production of a product. Products produced are enzymes, antibiotics, foods, acids, vitamins, polymers, and steroids.

Four specific examples of how the Culture Collection is involved in new fermentation processes are illustrated by current work in the Fermentation Laboratory:

1. The beta-carotene fermentation is carried out using Blakeslea trispora grown in a medium composed of hydrolyzed corn, vegetable oil, kerosene, and citrus pulp. The observation was made in the Collection that when two opposite mating types of this mold were placed together, beta-carotene was formed in larger amounts than either culture could produce singly. After work was underway, the Collection furnished all cultures for a survey and two better strains were found, both of which had been sent to the Collection for identification several years before. Blakeslea trispora is a good example of how some of the 100,000 species of fungi are geographically isolated, since it only occurs in the tropics and apparently there mainly on decaying flowers of certain plants.

2. The second fermentation is the polymer of Arthrobacter. The organism was isolated from Guatemala soil purposely for polymer production. The Collection in this investigation, furnished authentic strains for comparison, preserved the cultures and, of course, is distributing the producing strains.

3. Recent work has involved investigation of the amylase production by certain fungi and bacteria with the objective of converting corn starch to glucose to produce a suitable fermentable carbohydrate substrate. The cultures used are _Aspergillus_ _niger_ NRRL 337 which Dr. Thom requested in 1923 from Neuberg in Berlin for what purpose is unknown...(it was not until much later and after many years of transfer from culture to culture that its usefulness was discovered); and the bacterial culture NRRL B-941 which was isolated in 1949 by dilution-plating of bran in the Culture Collection.

4. The fourth fermentation is "tempeh" an Indonesian food made by the fermentation of soybeans by certain distinct strains of _Rhizopus_. The Culture Collection obtained a few cultures from exchange with other collections, but most of the cultures were isolated from the food as obtained in Indonesia.

In summary, the ARS Culture Collection: obtains pure cultures by isolation, exchange, and for identification; conserves microorganisms by four or more methods; does basic research in genetics and classification of microorganisms; supplies cultures to our Fermentation Laboratory and to other government laboratories; and distributes cultures and consults with industry. Therefore, because of all its activities, the Collection is indispensable to a fermentation program.

DISCUSSION

Most points for discussion with reference to the research reports presented were raised informally during and following the presentations, and consisted principally of clarification or amplification of statements made in the presentations.

In contrast to, and in consideration of, the extensive review of research needs outlined at the 1962 meeting, there was little discussion following the formal presentations. Satisfaction was expressed at the progress made in suggested areas of research under study and with the high caliber of the work reported. No major changes in emphasis were recommended.

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June 18, 1963

List of Attendance

CORN INDUSTRIES RESEARCH FOUNDATION TECHNICAL COMMITTEE

Corn Industries Research Foundation, Inc., Washington, D.C.
J. T. Goodwin, Jr., Technical Director
W. J. Hoover, Manager, Technical Services

American Maize-Products Company, Roby, Indiana
E. L. Powell, Assistant Director of Research
B. M. Winner, Associate Director of Research

Anheuser-Busch, St. Louis, Missouri
B. L. Scallet, Associate Director, Central Research
R. J. Sumner, Director, Central Research

Clinton Corn Processing Company, Clinton, Iowa
G. T. Peckham, Jr., Research Director
R. V. MacAllister
J. M. Newton

Corn Products Company, Argo, Illinois
Harry Gehman, Director of Research
A. L. Wilson, Assistant Director of Research

Hercules Powder Company, Wilmington, Delaware
R. E. Chaddock, Director of Development

The Hubinger Company, Keokuk, Iowa
J. M. Seitz, Director of Research
Roger Yarbrough, Chief Chemist

National Starch and Chemical Corporation, Plainfield, New Jersey
O. B. Wurzburg, Associate Director of Research
M. W. Rutenberg, Section Leader, Starch Research

Penick and Ford, Ltd., Cedar Rapids, Iowa
Erling Hjermstad, Research Chemist

A. E. Staley Company, Decatur, Illinois
J. A. Bralley, Vice President, Research and Development
E. E. Fisher, Head, Exploratory Section, Chemical Department

NORTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION
F. R. Senti, Director
W. C. Witham, Assistant Director
D. L. Miller, Assistant Director
H. M. Teeter, Assistant Director
W. C. Schaefer, Assistant to Director
J. E. Hubbard, Assistant to Director
W. K. Trotter, Agricultural Economist

Cereal Products Laboratory

C. E. Rist, Chief	C. L Mehltretter	C. R. Russell
T. R. Naffziger	W. M. Doane	T. E. Yeates
F. H. Otey		

Cereal Properties Laboratory

R. J. Dimler, Chief	S. R. Erlander	K. R. Sexson
G. E. Babcock	H. L. Griffin	J. S. Wall
C. W. Blessin	F. R. Huebner	M. J. Wolf
J. A. Boundy	J. P. McGuire	J. H. Woychik
T. M. Cotton	E. M. Montgomery	H. F. Zobel
W. L. Deatherage		

Engineering and Development Laboratory

E. L. Griffin, Chief	E. B. Lancaster	V. F. Pfeifer
R. A. Anderson	K. J. Moulton	

Fermentation Laboratory

R. W. Jackson, Chief	C. W. Hesseltine	A. Ciegler

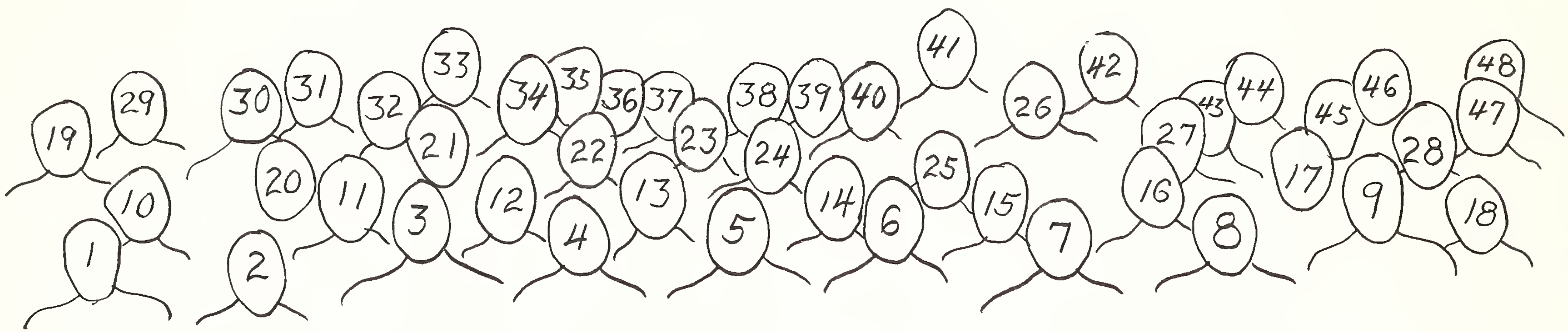
Industrial Crops Laboratory

T. F. Clark	C. H. VanEtten

ANNUAL CORN AND WHEAT UTILIZATION CONFERENCE

Northern Utilization Research and Development Division
and
Corn Industries Research Foundation
Technical Committee

Peoria, Illinois
June 18, 1963



First Row

1 C. W. Blessin
2 J. M. Newton
3 J. A. Bralley
4 F. R. Senti
5 J. T. Goodwin, Jr.
6 E. E. Fisher
7 G. T. Peckham, Jr.
8 H. Gehman
9 B. M. Winner

Second Row

10 E. M. Montgomery
11 W. J. Hoover
12 O. B. Wurzburg
13 A. L. Wilson
14 R. Yarbrough
15 R. V. MacAllister
16 E. L. Powell
17 S. R. Erlander
18 J. P. McGuire

Third Row

19 C. E. Rist
20 B. L. Scallet
21 H. M. Teeter
22 E. Hjermstad
23 J. S. Wall
24 D. L. Miller
25 M. Rutenberg
26 R. J Sumner
27 J. M. Seitz
28 H. F. Zobel

Top Rows

29 J. E. Hubbard
30 J. H. Woychik
31 W. C. Witham
32 C. L. Mehltretter
33 E. L. Griffin
34 H. L. Griffin
35 R. A. Anderson
36 W. C. Schaefer
37 V. F. Pfeifer
38 C. L. Swanson
39 W. L. Deatherage
40 R. E. Chaddock
41 W. M. Doane
42 R. J. Dimler
43 K. R. Sexson
44 T. M. Cotton
45 G. E. Babcock
46 E. B. Lancaster
47 T. R. Naffziger
48 K. J. Moulton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